



Application No:

GQTS/D201608007

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Test Report

Company Name: YUEQING FEEO ELECTRIC CO., LTD.

Company Address: Liushi Yueqing Zhejiang China

Product Name: SURGE PROTECTIVE DEVICE

TEST REPORT	
EN 61643-11	
Low-voltage surge protective devices –	
Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods	
Report reference No	GQTS/D201608007
Tested by (name and signature).....	Rocky 
Approved by (name and signature) :	Bruce 
Date of issue.....	31/08/2016
Testing Laboratory Name	BEIDE (UK) PRODUCT SERVICE LIMITED
Address	6F, BLDG E, HOURUI 3 RD IND ZONE, XIXIANG, BAO'AN DIST, SHENZHEN, CHINA
Testing location	6F, BLDG E, HOURUI 3 RD IND ZONE, XIXIANG, BAO'AN DIST, SHENZHEN, CHINA
Applicant's Name	YUEQING FEEO ELECTRIC CO., LTD.
Address.....	Liushi Yueqing Zhejiang China
Test specification	
Standard	EN 61643-11:2012
Test procedure	CE
Non-standard test method	N/A
Test Report Form	
Test Report Form No.	EN 61643-1A/16-08
Master TRF	Dated 16-08
Test item description.....	
Trademark	FEEO
Manufacturer :	YUEQING FEEO ELECTRIC CO., LTD.
Model and/or type reference.....	FSP-A40
Rating(s)	Uc:275VAC
Test items particulars:	
Additional information	/
National requirements.....	/
Other requirements.....	/

Test case verdicts

Test case does not apply to the test object ... : N/A

Test item does meet the requirement..... : P(ass)

Test item does not meet the requirement..... : F(ail)

Testing

Date of receipt of test item..... : 02/08/2016

Date(s) of performance of test..... : 02/08/2016-31/08/2016

General remarks

This report shall not be reproduced except in full without the written approval of the testing laboratory.

The test results presented in this report relate only to the item(s) tested.

"(See remark #)" refers to a remark appended to the report.

"(See Annex #)" refers to an annex appended to the report.

Throughout this report a comma is used as the decimal separator.

"This report is not valid as a CB Test Report unless appended to a CB Test Certificate issued by a NCB, in accordance with IEC 60730-2".

Copy of marking plate:

SURGE PROTECTIVE DEVICE

Model No.: FSP-A40

Rating: Uc: 275VAC

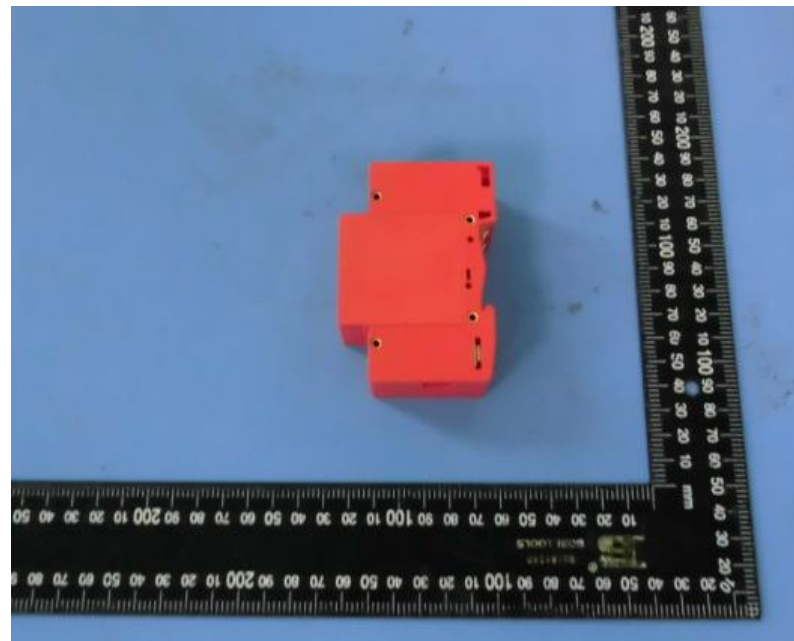
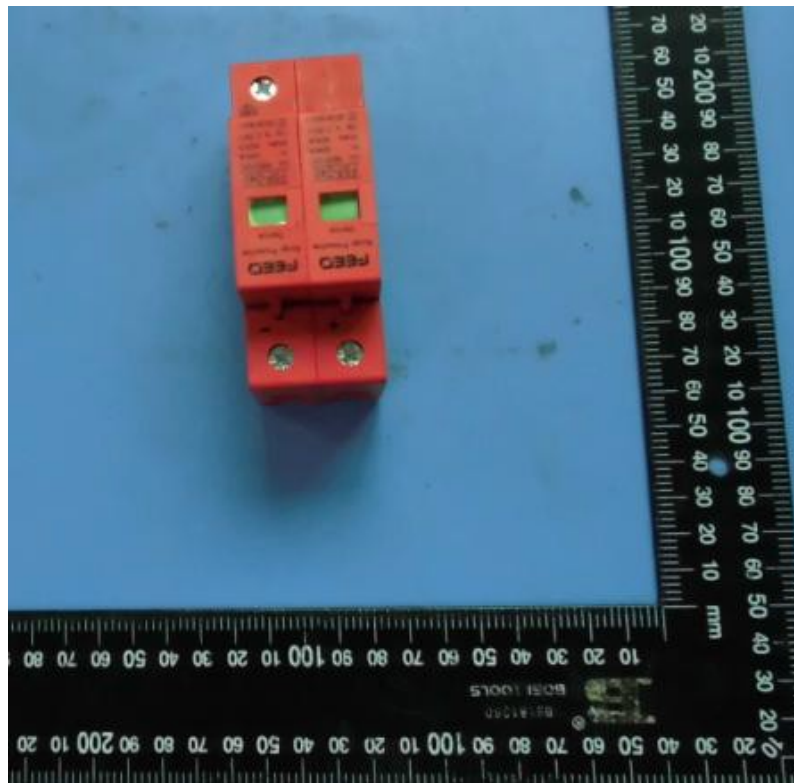


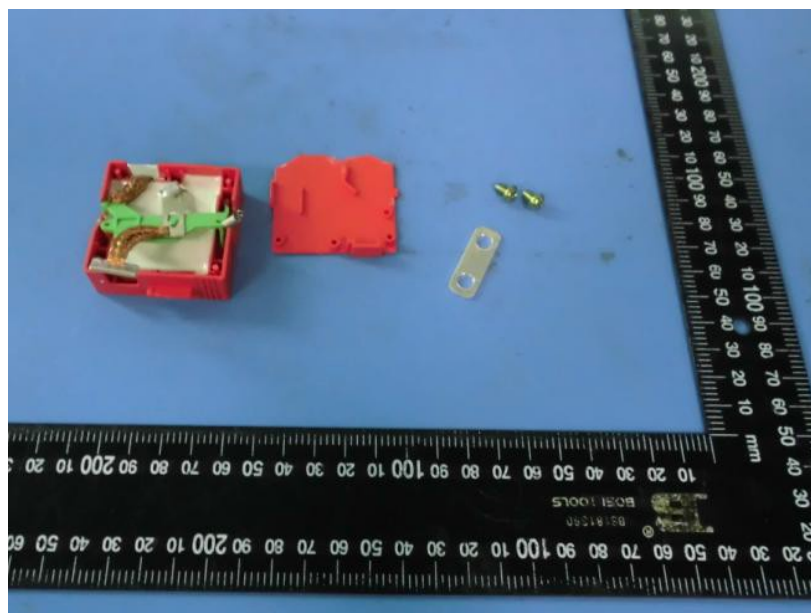
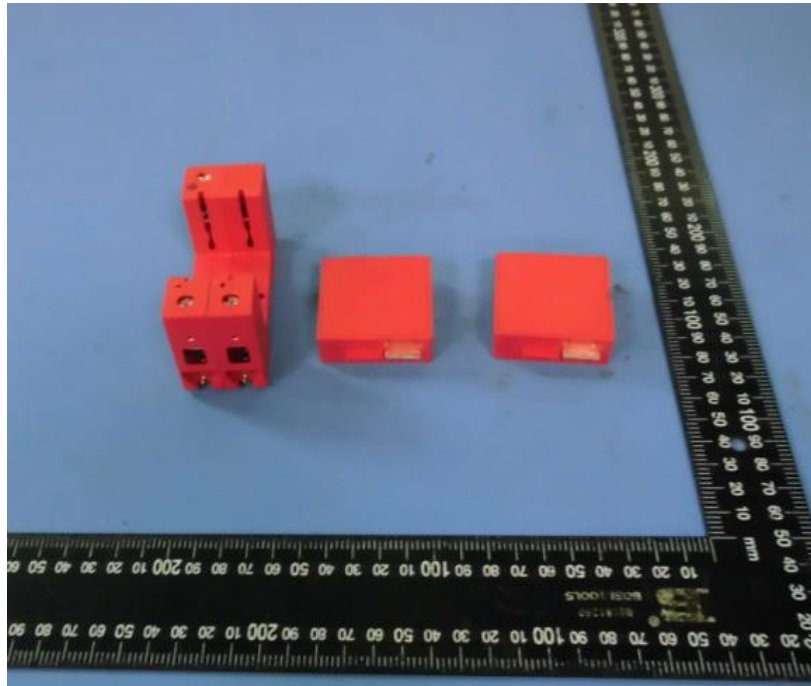
YUEQING FEEO ELECTRIC CO., LTD

Liushi, Yueqing, Zhejiang, China

Made In China

Photographs of EUT:





EN 61643-11			
Cl.	Requirement – Test	Result	Verdict
4	Requirements		—
4.1	Number of ports		P
4.2	SPD design topology	Voltage limiting type	P
4.3	SPD types 1, 2 and 3 - test classes I, II and III		P
4.4	Location	Indoor	P
4.5	Accessibility	Inaccessible (out-of-reach)	P
4.6	Mounting method	Fixed	P
4.7	SPD disconnect		P
4.7.1	Location	Internal	P
4.7.2	Protection functions	Thermal, overcurrent	P
4.8	Overcurrent protection	Specified	P
4.9	Degree of protection provided by enclosures according to IP codes of IEC 60529	IP20	P
4.10	Temperature range	Extended (-40°C~80°C)	P
4.11	Multipole SPD		P
5	Standard ratings		—
5.1	Preferred values of peak impulse current for class I tests I_{peak}		N/A
5.2	Preferred values of nominal discharge current for class II tests I_n	10 kA	P
5.3	Preferred values of open-circuit voltage for class III tests U_{oc}		N/A
5.4	Preferred values of voltage protection level U_p	≤ 1.0 kV	N/A
5.5	Preferred values of r.m.s. or d.c. maximum continuous operating voltage U_c		P
5.6	Preferred values for I_{Total}		P
6	Requirements		P
6.1	General requirements		P
6.1.1	Identification		P

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Cl.	Requirement – Test	Result	Verdict
	The following minimum information shall be provided by the manufacturer. Tested in accordance with clause 7.	YUEQING FEEO ELECTRIC CO.,LTD	P
	a)Manufacturer's name or trade mark and model number	FSP-A40	P
	b)Location category	Indoor	P
	c)Number of ports	One-port SPD	P
	d)Method of mounting	Fixed	P
	e)Maximum continuous operating voltage Uc (one value for each mode of protection except if all values are equal)		P
	f)SPD type and discharge parameters for each mode of protection declared by the manufacturer:	Type 2 I _{max} : 20 kA	P
	g) Nominal discharge current I _n for Type 1 and Type 2 SPDs (one value for each mode of protection)	10 kA	P
	h)Voltage protection level Up (one value for each mode of protection)	≤1.0 kV	P
	i)Rated load current I _L (if required)		N/A
	j)Degree of protection provided by the enclosure (IP code) (if IP > 20)	IP20	N/A
	k)Short-circuit withstand		P
	l)Maximum recommended ratings of overcurrent protection (if applicable)		N/A
	m)Indication of disconnector operation (if any)		P
	n)Position of normal use if significant		P
	o)Identification of terminals (if necessary)		P
	p)installation instructions (e.g. type of LV systems: TN, TT, IT etc , connections to LV systems and rated system voltages for which the SPD is designed, mechanical dimensions, lead lengths, etc.)	TT, TN, IT	P
	q)Type of current: a.c. frequency or d.c., or both		P
	r)Specific energy W/R for Type 1 SPDs only (from 7.1.1)		N/A
	s) Temperature range	-40°C~80°C	P
	t)Follow current interrupting rating (except in the case of voltage limiting SPDs)	voltage limiting SPD	N/A
	u)The external SPD disconnector requirements, if any, shall be defined by the manufacturer		N/A
	v)Residual current (optional)		P

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Cl.	Requirement – Test	Result	Verdict
	w) Temporary overvoltage characteristic		P
	x) Total discharge current I_{Total} for multipole SPDs (if declared by the manufacturer)		P
6.1.2	Marking		P
	Markings a), e), f), g), h), j), l), o) and q) in 6.1.1 are mandatory on the body, or permanently attached to the body, of the SPD.	See marking label	P
	Marking shall be indelible and legible and shall not be placed on screws and removable washers. Compliance is in accordance with the test of 7.2.	On enclosure	P
6.2	Electrical requirements		P
6.2.1	Electrical connections		P
	Terminals shall be designed for the connection of cables having a minimum and a maximum cross-sectional area according to the manufacturer declaration.	10-16 mm ²	P
	Each of the tests must be passed by using the most severe configuration (i.e. the maximum or minimum cross-sectional area depending on the test (see clause 7)).		P
6.2.2	Voltage protection level Up		P
	The measured limiting voltage of SPDs shall not exceed the voltage protection level that is specified by the manufacturer. Compliance is in accordance with the test of 7.5.	See clause 7.5	P
6.2.3	Class I impulse current test(s)		N/A
	An SPD shall be tested to class I test when the manufacturer declares that it meets those requirements. Compliance is in accordance with the test of 7.6.5.		N/A
6.2.4	Class II nominal discharge current test(s)		P
	An SPD shall be tested to class II test when the manufacturer declares that it meets those requirements. Compliance is in accordance with 7.6.5.		P
6.2.5	Class III combination wave test(s)		N/A
	An SPD shall be tested to class III test when the manufacturer declares that it meets those requirements. Compliance is in accordance with the test of 7.6.7.		N/A
6.2.6	Operating duty test		P

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Cl.	Requirement – Test	Result	Verdict
	The SPD shall be capable of withstanding specified discharge currents during application of the maximum continuous operating voltage U_c without unacceptable changes in its characteristics. Compliance is in accordance with the test of 7.6.	See clause 7.6	P
6.2.7	SPD disconnecter		P
	The SPD may have SPD disconnectors (which can be either internal, external or both). Their operation shall be indicated.	Internal	P
6.2.8	Air clearances and creepage distances		P
	The SPD shall have sufficient air clearances and creepage distances. Testing is in accordance with 7.9.5.	See clause 7.9.5	P
6.2.9	Tracking resistance		P
	Insulating materials necessary to retain live parts in their position shall be composed of nontracking material, or they shall be sufficiently dimensioned. Testing in accordance with 7.9.6.	See clause 7.9.6	P
6.2.10	Dielectric withstand		P
	The dielectric withstand of the housing of the SPD shall be sufficient with respect to insulation breakdown and protection against direct contact. Testing in accordance with 7.9.8.	See clause 7.9.8	P
6.2.11	Short-circuit withstand capability		P
	An overstressed (short-circuited) SPD shall withstand the power short-circuit currents that may occur in service. Testing is in accordance with 7.7.3.	See clause 7.7.3	P
6.2.12	Status indicator operation		P
	General Requirements		P
	Throughout the entire type testing procedure, the status shown by the indicator(s) shall give a clear sign of the status of the part to which it is linked. For an SPD with a stated intermediate status indication, the intermediate status is not considered as a failure of the indicator. Where there is more than one method of status indication, for example local and remote indication, each type of indication shall be checked. The manufacturer shall provide information about the function of the indicator and the actions to be taken after change of status indication.		P

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Cl.	Requirement – Test	Result	Verdict
	A status indicator may be composed of two parts, (one of which is not replaced on replacement of the SPD) linked by a coupling mechanism which can be mechanical, optical, audio, electromagnetic, etc.		P
	In this situation, the part of the status indicator with the replaced part of the SPD shall be tested as above. The part of the status indicator which is not replaced shall be capable of operating at least 50 times.		P
	Where there is an appropriate standard for the type of indication used, this shall be met by the non-replaced part of the status indicator, with the exception that the indicator need only be tested for 50 operations.		P
6.2.13	Isolation between separate circuits		P
	Where a SPD includes a circuit which is electrically isolated from the main circuit, the manufacturer shall provide information about the isolation and dielectric withstand voltages between the circuits as well as the relevant standards with which the manufacturer is claiming conformity.		P
	Where there are more than two circuits, declarations shall be made with regard to each combination of circuits.		P
	The isolation and dielectric withstand of the separate circuits shall be tested according to the manufacturer's declaration.		P
6.3	Mechanical requirements		P
	SPDs shall be provided with appropriate means for mounting that will ensure mechanical stability. Testing in accordance with 7.9.2.	See clause 7.9.2	P
6.3.1	General		P
	The SPD shall be equipped with terminals where electrical connection is possible by means of:	terminal with screw	P
6.3.2	Mechanical connectionsP		P
	a) Terminals shall be fastened to the SPD in such a way that they will not work loose if the clamping screws or the lock nuts are tightened or loosened. A tool shall be required to loosen the clamping screws or the lock nuts.		P
	b) Plugs and socket outlets shall correspond to the relevant national requirements, and those clauses of IEC 60884-1 that may apply.		N/A
	c) Screws, current-carrying parts and connections		P

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Cl.	Requirement – Test	Result	Verdict
	1) Connections, whether electrical or mechanical, shall withstand the mechanical stresses occurring in normal use.		P
	Screws operated when mounting the SPD during installation shall not be of the threadcutting type.		P
	Compliance is checked by inspection and tested in accordance with 7.3.2.1.		P
	2) Electrical connections shall be so designed that contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with characteristics no less suitable, unless there is sufficient resilience in the metallic parts to compensate for any possible shrinkage or yielding of the insulating material.		P
	Compliance is checked by inspection.		P
	The suitability of the material is considered in respect of the stability of the dimensions.		P
	3) Current-carrying parts and connections including parts intended for protective conductors, if any, shall be of either		P
	- copper, or	Copper	P
	- an alloy containing at least 58 % copper for parts worked cold, or at least 50 % copper for other parts, or		N/A
	- other metal or suitably coated metal, no less resistant to corrosion than copper and having mechanical properties no less suitable.		N/A
	New requirements and appropriate tests for determining the resistance to corrosion are under consideration. These requirements should permit other materials to be used if suitably coated.		P
	The requirements of this subclause do not apply to contacts, magnetic circuits, heater elements, bimetals, current-limiting materials, shunts, parts of electronic devices nor to screws, nuts, washers, clamping plates and similar parts of terminals.		P
	d)Terminals with screw for external conductors		P
	1) Terminals for external conductors shall be such that the conductors may be connected so as to ensure that the necessary contact pressure is maintained permanently.		P
	Such arrangements may be either of the plug-in or of the bolt-on type.	bolt-on type	P

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Cl.	Requirement – Test	Result	Verdict
	The terminals shall be readily accessible under the intended conditions of use.		P
	Compliance is checked by inspection and tested in accordance with 7.3.2.2.2.		P
	2)The means for clamping the conductors in the terminals shall not serve to fix any other component, although they may hold the terminals in place or prevent them from turning.		P
	Compliance is checked by inspection and tested in accordance with 7.3.2.2.2.		P
	3)Terminals shall have adequate mechanical strength. Screws and nuts for clamping the conductors shall have a metric ISO thread or a thread comparable in pitch and mechanical strength.		P
	Compliance is checked by inspection and tested in accordance with 7.3.2.1 and 7.3.2.2.		P
	Provisionally, SI, BA and UN threads may be used as they are virtually equivalent in pitch and mechanical strength to metric ISO threads.		P
	4) Terminals shall be so designed that they clamp the conductor without undue damage to the conductor.		P
	Compliance is checked by inspection and tested in accordance with 7.3.2.2.2.		P
	5) Terminals shall be so designed that they clamp the conductor reliably and between metal surfaces.		P
	Compliance is checked by inspection and tested in accordance with 7.3.2.1 and 7.3.2.2.1.		P
	6) Terminals shall be so designed or positioned that neither a rigid solid conductor nor a wire of a stranded conductor can slip out while the clamping screws or nuts are tightened.		P
	This requirement does not apply to lug terminals.		P
	Compliance is checked by inspection and tested in accordance with 7.3.2.2.3.		P
	7) Terminals shall be so fixed or located that, when the clamping screws or nuts are tightened or loosened, the terminals shall not work loose from their fixings to the SPDs.		P

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Cl.	Requirement – Test	Result	Verdict
	These requirements do not imply that the terminals shall be so designed that their rotation or displacement is prevented, but any movement shall be sufficiently limited so as to prevent non-compliance with the requirements of this standard.		P
	The use of sealing compound or resin is considered to be sufficient for preventing a terminal from working loose, provided that		P
	-the sealing compound or resin is not subject to stress during normal use, and		P
	-the effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the most unfavorable conditions specified in this standard.		P
	Compliance is checked by inspection, by measurement and tested in accordance with 7.3.2.1.		P
	8) Clamping screws or nuts of terminals intended for the connection of protective conductors shall be adequately secured against accidental loosening.		P
	Compliance is checked by manual test.		P
	e) Screwless terminals for external conductors	No screwless terminals	N/A
	1) Terminals shall be so designed and constructed that		N/A
	- each conductor is clamped individually. During the connection or disconnection the conductors can be connected or disconnected either at the same time or separately;		N/A
	-it is possible to clamp securely any number of conductors up to the maximum provided.		N/A
	Compliance is checked by inspection and tested in accordance with 7.3.3.		N/A
	2)Terminals shall be so designed and constructed that they clamp the conductor without undue damage to the conductor		N/A
	Compliance is checked by inspection.		N/A
	f)Insulation pierced connections for external conductors		P

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Cl.	Requirement – Test	Result	Verdict
	1) The insulation pierced connections shall make a reliable mechanical connection. Compliance is checked by inspection and tested in accordance with 7.3.4.		P
	2) Screws for making contact-pressure shall not serve to fix any other component, although they may hold the SPD in place or prevent it from turning.		P
	Compliance is checked by inspection.		P
	3) Screws shall not be of metal which is soft or liable to creep.		P
6.3.3	Corrosive resistant metals		P
	Clamps, except clamping screws, lock nuts, binding clip thrust washers, wire, and similar, shall consist of corrosion resistant metal such as copper, brass, etc. (see IEC 60999).		P
6.4	Environmental requirements		P
	SPDs shall be designed in such a way that they operate satisfactorily under the environmental conditions given by the normal service conditions.		P
	They shall have sufficient surface creepage distance between any two parts of different potential.		P
6.5	Safety requirements		P
	SPDs shall be safe when operated under normal service conditions in accordance with the recommendation.		P
6.5.1	Protection against direct contact		P
	These requirements are valid for accessible SPDs where the maximum continuous operating voltage U_c is above 50 V r.m.s. a.c.		P
	For protection against direct contact (inaccessibility of live parts), SPDs shall be designed in such a way that live parts cannot be touched when the SPD is installed for the intended use. Compliance is verified by standardized test methods of IEC 60529 and to 7.4.	IP20	P
	SPDs, except SPDs classified as inaccessible, shall be so designed that, when they are wired and mounted as for normal use, live parts are not accessible, even after removal of parts which can be removed without the use of a tool.		P
	Compliance is checked by inspection and, if necessary, by the tests of 7.4.1.		P

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Cl.	Requirement – Test	Result	Verdict
	The connection between the earthing terminals and all accessible parts connected thereto shall be of low resistance. Compliance is checked by the test according to 7.4.2.		P
6.5.1.1	Mechanical strength		P
	All parts of the SPD relating to the protection against direct contact shall have sufficient mechanical strength. Compliance is tested in accordance with 7.9.2.	See clause 7.9.2	P
6.5.1.2	Heat resistance		P
	All parts relating to the protection against direct contact shall be sufficiently heat resistant. Compliance is tested in accordance with 7.9.3.	See clause 7.9.3	P
6.5.1.3	Insulation resistance		P
	The insulation resistance of the SPD shall be sufficient. Compliance is tested in accordance with 7.9.7.	See clause 7.9.7	P
6.5.2	Fire resistance		P
	Insulating parts of the housing shall be either nonflammable or self-extinguishing. Compliance is tested in accordance with 7.9.4.	See clause 7.9.4	P
6.5.3	Standby power consumption PC		P
	For all SPDs, the PC shall be measured at the SPD's maximum continuous operating voltage (UC) when connected according to the manufacturer's instructions without a load.		P
6.5.4	Residual current		N/A
	For all SPDs with a terminal for the protective conductor, the residual current shall be measured at the SPD's maximum continuous operating voltage (UC) when connected according to the manufacturer's instructions, without a load.		N/A
6.5.5	Behaviour under temporary overvoltages		P
	An SPD shall either withstand a TOV without changes in functionality, or fail in a manner described in 7.7.4 and 7.7.6.		P
6.5.5.1	TOVs caused by faults in the high (medium) voltage system		P
	SPDs connected to PE and for use on power distribution systems shall be tested at UT in accordance with 7.7.4 and Table B.1.		P
6.5.5.2	TOVs caused by faults or disturbances in the low voltage system		P

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Cl.	Requirement – Test	Result	Verdict
	If U_c is greater or equal to U_T there is no need to perform this test.		P
	All other SPDs shall be tested using either the TOV voltages U_T given in Table B.1 or the TOV voltages stated by the manufacturer according to 6.1.1 w), whichever values are higher. This test shall be performed in accordance with 7.7.6.		P
6.5.6	Total discharge current I_{Total}		P
	This test is only conducted if the manufacturer claims a total discharge current in accordance with 7.9.10.	See clause 7.9.10	P
6.6	Additional test requirements for two-port SPDs and one-port SPDs with separate input/output terminals	See clause 7.9.10	P
6.6.1	Percent of voltage regulation		P
	The percent of voltage regulation shall be declared by the manufacturer and tested in accordance with 7.8.1.		P
6.6.2	Rated load current I_L		N/A
	The rated load current shall be declared by the manufacturer and tested in accordance with 7.8.2.		N/A
6.6.3	Load-side surge withstand capability		P
	When the value for load-side surge withstand capability is declared by the manufacturer it shall be tested in accordance with 7.8.4.		P
6.6.4	Overload behaviour		P
	The SPD shall not be damaged or altered by overloads, which may occur in normal use. Compliance with this requirement is checked according to 7.8.5.	See clause 7.8.5	P

7	Type tests		P
	Type tests are carried out as indicated in Table 2 on three samples per test series. Within any test series, the tests shall be carried out in the order given in Table 2. The order in which test series are carried out may be varied.		P
7.1	General testing procedures		P
	If not otherwise specified, the reference standard for testing procedure is IEC 61180-1.		P
	Unless otherwise specified, a.c. values given in this standard are r.m.s values.		P

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Cl.	Requirement – Test	Result	Verdict
	The SPD shall be mounted and electrically connected in accordance with the manufacturer's installation procedures. Neither external cooling nor heating shall be employed.		P
	When not otherwise specified, the test shall be performed in free air and the ambient temperature shall be $20^{\circ}\text{C} \pm 15^{\circ}\text{C}$.		P
	If not otherwise specified, for all tests where a power supply at UC is required, the voltage tolerance for testing shall be $U_c \pm 5\%$.		P
	When testing SPDs for which the manufacturer supplies integral cables, the full length of those cables shall form part of the SPD under test.		P
	During the test, no maintenance or dismantling of the SPD is allowed.		P
	It should be noted that good testing techniques are required for impulse testing and measurements. This is needed to ensure that correct test values are recorded.		P
	If the manufacturer sets different requirements for the external SPD disconnector(s) depending upon the prospective short-circuit current of the supply system, all relevant test sequences shall be performed for every combination of required SPD disconnector(s) and corresponding prospective short-circuit currents.		P
7.1.1	Class I impulse current test		N/A
	The test impulse current I_{imp} is defined by its parameters peak value I_{peak} , charge Q and specific energy W/R . The unipolar test impulse current shall obtain I_{peak} within $50 \mu\text{s}$ and the charge Q and the specific energy W/R within 10 ms.		N/A
7.1.2	Class I and class II nominal discharge current test		P
	The standard waveshape is 8/20. The tolerances on the current waveshape are the following:		P
	-peak value $\pm 10\%$		P
	-front time $\pm 10\%$		P
	-time to half value $\pm 10\%$		P
	A small overshoot or oscillation is tolerated provided that the amplitude of any oscillation is not more than 5 % of the peak value. Any polarity reversal after the current has fallen to zero shall not be more than 20 % of the peak value.		P

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Cl.	Requirement – Test	Result	Verdict
	In the case of two port devices, the magnitude of the reversal shall be less than 5 %, so that it does not affect the measured limiting voltage.		P
7.1.3	Class I and II voltage impulse test		N/A
	Oscillations exceeding 3 % of the peak value are not allowed at the rising portion of the voltage impulse.		N/A
	The measuring devices shall have an overall bandwidth of at least 25 MHz and the overshoot shall be less than 3 %.		N/A
	Oscillations or overshoot may occur at the crest of the impulse. If the frequency of such oscillations is more than 500 kHz or the duration of the overshoot is less than 1 μ s, a mean curve shall be drawn and, for the purpose of the measurement, the maximum amplitude of this curve defines the peak value of the test voltage.		N/A
	The measuring devices shall have an overall bandwidth of at least 25 MHz, and the overshoot shall be less than 3 %.		N/A
	The short-circuit current of the test generator shall preferably be less than 20 % of the nominal discharge current I_n , but sufficient to ensure that the SPD's voltage switching component(s) conduct during the test.		N/A
7.1.4	Class III combination wave test		N/A
	The standard impulse of a combination waveform generator is characterized by the output voltage under open-circuit conditions and the output current under short-circuit conditions. The open-circuit voltage shall have a front time of 1,2 μ s and a time to half value of 50 μ s. The short-circuit current shall have a front time of 8 μ s and a time to half value of 20 μ s.		N/A
	The following values are measured on the generator without a back filter.		N/A
	The tolerances on open circuit voltage U_{oc} shall be the following:		N/A
	-peak value ± 3 %		N/A
	-front time ± 30 %		N/A
	-time to half value ± 20 %		N/A

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Cl.	Requirement – Test	Result	Verdict
	Voltage overshoot or oscillations in the neighborhood of the crest are acceptable provided that the single peak amplitude is less than 5 % of the peak value. In commonly used impulse generator circuits, oscillations on that part of the wave front during which the voltage does not exceed 90 % of the peak value have generally negligible influence on the test results and thus may be disregarded. The voltage waveform shall be essentially unidirectional.		N/A
	The tolerances on the short-circuit current shall be the following:		N/A
	-peak value ± 10 %		N/A
	-front time ± 10 %		N/A
	-time to half value ± 10 %		N/A
	A current overshoot or oscillations are tolerated provided that their single peak amplitude at the crest of the waveform is less than 5 % of the peak value. Any polarity reversal after the current has fallen to zero shall be less than 20 % of the peak value.		N/A
	In the case of two port devices the magnitude of the current reversal shall be less than 5 %, so that it does not affect the measured limiting voltage.		N/A
	The fictive impedance of the generator shall be nominally 2 Ω . By definition, the fictive impedance is the ratio of the peak value of the open-circuit voltage U_{oc} divided by the peak value of the short-circuit current I_{sc} .		N/A
	The maximum values for peak open-circuit voltage U_{oc} and peak short-circuit current I_{sc} are 20 kV and 10 kA respectively. Above these values (20 kV /10 kA), type II tests shall be performed.		N/A
	Insert a decoupling network (back filter) according to figures 1 or 2. This circuit configuration will be used only for determining the measured limiting voltage of the SPD.		N/A
7.1.5	Testing of SPDs classified outdoor only and for mounting out of reach	Indoor use	N/A
	For SPDs classified outdoor only and for mounting out of reach, the tests of 7.7 and 7.8 are performed without the cubic wooden box.		N/A
7.2	Identification and marking		P
7.2.1	Verification of the identification and markings		P

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Cl.	Requirement – Test	Result	Verdict
	Verification of the identification and markings shall be checked against the respective requirements of 6.1.1 and 6.1.2 by inspection.	Markings marked on enclosure	P
7.2.2	Test of indelibility of markings		P
	This test shall be applied on markings of all types except those made by impressing, molding and engraving.		P
	The test is made by rubbing the marking by hand for 15 s with a piece of cotton soaked with water and again for 15 s with a piece of cotton soaked with aliphatic solvent hexane (with a content of aromatics of maximum 0,1 % volume, a kauributanol value of 29, initial boiling-point approximately 65°C and specific gravity of 0,68 g/cm ³).	After this test, the marking still easily legible.	P
7.3	Terminals and connections		P
	Verification of the incorporated terminals and their conformity is met by the requirements of 7.3.1.		P
7.3.1	General testing procedure		P
	The SPD is mounted according to the manufacturer's recommendation, and is protected against undue external heating or cooling.		P
	Unless otherwise specified, the SPD terminals (3 samples of each construction used) shall be wired with conductors according to		P
	-table 6 for two-port devices and one-port devices with separate input/output terminals,		N/A
	-the manufacturer's instruction for other one-port devices,	Conductors for L/N: min.10 mm ² ; conductor for PE: min.16 mm ²	P
	and fixed on a dull, black-painted wood board of about 20 mm thickness. The method of fixing shall comply with any requirements relating to the means of mounting recommended by the manufacturer.		P
	Nevertheless, SPDs tested according to class I and one-port SPDs with a nominal discharge current ≥ 5 kA tested according to class II shall be capable of clamping conductors up to a cross-section of at least 4 mm ² .		N/A
	During the test, no maintenance or dismantling of the sample is allowed.		P
7.3.2	Terminals with screws		P

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Cl.	Requirement – Test	Result	Verdict
7.3.2.1	Test of reliability of screws, current-carrying parts and connections		P
	Compliance is checked by inspection and for screws which are operated when connecting up the SPD by the following test.		P
	The screws are tightened and loosened		P
	-ten times for screws in engagement with a thread of insulating material,		N/A
	-five times in all other cases		P
	Screws or nuts in engagement with a thread of insulating material are completely removed and reinserted each time unless the construction of the screw prevents this.		N/A
	The test is made by means of a suitable test screwdriver or spanner applying a torque as shown in table 5.	1.2 Nm torque test	P
	The screws shall not be tightened in jerks.		P
7.3.2.2	Test of reliability of terminals for external conductors		P
	Compliance is checked by inspection and tested in accordance with 7.3.2.2.1, 7.3.2.2.2 and 7.3.2.2.3.		P
	These tests are made by means of a suitable screwdriver or spanner applying a torque as shown in table 5.	1.2 Nm torque test	P
7.3.2.2.1	The terminals are fitted with copper conductors of the smallest or largest crosssectional areas specified in 7.3.1, solid or stranded, whichever is most unfavourable.		P
	The conductor is inserted into the terminal for the minimum distance prescribed or, where no distance is prescribed, until it just projects from the far side, and in the position most likely to assist the wire to escape.		P
	Each conductor is then subjected to a pull of the value, in newtons, shown in table 7. The pull is applied without jerks, for 1 min, in the direction of the axes of the conductor space.	90N for 1 min. During this test, the conductor not move noticeably in the terminal.	P

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Cl.	Requirement – Test	Result	Verdict
7.3.2.2.2	The terminals are fitted with copper conductors of the smallest or largest crosssectional areas specified in 7.3.1 solid or stranded, whichever is the most unfavourable and the terminal screws are tightened with a torque equal to two-thirds of that shown in the appropriate column of table 5. The terminal screws are then loosened and the part of the conductor which may have been affected by the terminal is inspected.		P
	The conductors shall show neither undue damage nor severed wires.		P
	Conductors are considered to be unduly damaged if they show deep or sharp indentations.		P
	During the test, terminals shall not work loose and there shall be no damage such as breakage of screws or damage to the head slots, threads, washers or stirrups, that will impair the further use of the terminal.		P
7.3.2.2.3	The terminals are fitted with a rigid stranded copper conductor conforming to table 8.		P
	Before insertion in the terminal, the wires of the conductors are suitably reshaped.		P
	The conductor is inserted into the terminal until the conductor reaches the bottom of the terminal or just projects from the far side of the terminal and in the position most likely to assist a wire to escape. The clamping screw or nut is then tightened with a torque equal to two-thirds of that shown in the appropriate column of table 5.	Stranded conductors for L/N: 7x1.35 mm; Stranded conductor for PE: 7x1.70 mm	P
	After the test, no wire of the conductor shall have escaped from the SPD terminal.		P
7.3.3	Screwless terminals	No screwless terminals	N/A
	Pull out test		N/A
	Compliance is checked by the following tests.		N/A
	The terminals are fitted with new conductors of the type and of the minimum and maximum cross-sectional areas as specified in 7.3.1, solid or stranded, whichever is the most unfavourable.		N/A
7.3.4	Insulation pierced connections		P
7.3.4.1	Pull out test on SPD terminals designed for single core conductors		P
	Compliance is checked by the following tests.		P

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Cl.	Requirement – Test	Result	Verdict
	The terminals are fitted with new copper conductors of the smallest or largest cross-sectional area specified in 7.3.1. solid or stranded, whichever is most unfavourable.		P
	During the test, there shall be no movement of the conductor in the terminal or any sign of damage.		P
7.3.4.2	Pull out test on SPD terminals designed for multi-core cables or cords		N/A
	The pull-out test on the SPD terminals designed for multi-core cables or cords is carried out according to 7.3.4.1 except that the pull force is applied to the entire multicore cable or cord instead of to the individual core.		N/A
7.3.5	Nuts, plug, socket	Nuts	P
	Compliance is checked by inspection and trial mounting.		P
7.4	Testing for protection against direct contact		P
7.4.1	Insulated parts		P
	The sample is mounted as for normal use and fitted with conductors of the smallest cross-sectional area and the test repeated using conductors of the largest cross-sectional area specified in 7.3.1.		P
	The standard test finger (in accordance with IEC 60529) is applied in every possible position.		P
	For plug-in SPDs (which can be changed without a tool), the test finger is applied in every possible position, when the plug is partially engaged or completely engaged with a socket outlet.	Not plug-in SPDs	N/A
	An electrical indicator with a voltage of not less than 40 V and not more than 50 V is used to show contact with the relevant part.		P
7.4.2	Metal parts		P
	Metal parts which are accessible when the SPD is wired and mounted as for normal use have to be connected to earth through a low resistance connection, except of small screws and the like, isolated from live parts, for fixing bases and covers or cover plates of socket-outlets.		P

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Cl.	Requirement – Test	Result	Verdict
	A current (derived from an a.c. source having a no-load voltage not exceeding 12 V) equal to 1,5 times the rated load current or 25 A, whichever is the greater, is passed between the earthing terminal and each of the accessible metal parts in turn.		P
	The voltage drop between the earthing terminal and the accessible metal part is measured and the resistance is calculated from the current and this voltage drop. The resistance shall not exceed 0.05 .	<0.05Ω	P
7.5	Determination of the measured limiting voltage		P
	The tests to be performed on the different SPD types to determine their measured limiting voltages are according to the following table 10 and the flow chart in figure 3.		P
	The following specific test conditions apply.		P
	a) All one-port SPDs shall be tested unenergized. All two-port SPDs are to be tested energized by means of a voltage source having a nominal current of at least 5 A at U_c , unless the manufacturer can show that there is no difference in the value of the measured limiting voltage when the device is energized or unenergized.		P
	b) For a one-port SPD having terminals, the test is performed without external disconnectors and the measured limiting voltage is measured at the terminals. For a one-port SPD having connecting leads, the measured limiting voltage is measured with an external lead length of 150 mm.		P
	c) The measured limiting voltage is the highest voltage value of the tests performed according to table 10 and figure 3, relevant to the SPD test class.		P
7.5.1	Test procedure to determine the presence of a switching (crowbar) component in an SPD		P
	This test has to be performed only if the internal design of the SPD is not known. A new sample shall be used for this test only.		P
	The standard 8/20 current impulse is used for class I and class II tests of SPDs with a magnitude of I_{max} or I_{peak} as declared by the manufacturer. For class III test of an SPD, a combination wave generator shall be used with an open-circuit voltage equal to the U_{oc} declared by the manufacturer.		P

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Cl.	Requirement – Test	Result	Verdict
	One impulse shall be applied to the SPD (in the case of a two-port SPD, the impulse shall be applied to its input and output terminals).		P
	Oscillographic record of the voltage across the SPD shall be taken (in the case of a two-port SPD, the voltage measurement shall be taken across the input terminal of the SPD).		P
	If the waveshape of the recorded voltage shows a sudden collapse, the SPD is considered as containing a switching (crowbar) component.		P
7.5.2	Test procedure to measure the residual voltage with 8/20 current impulses		P
	a)The 8/20 current impulses shall be used with a sequence of peak values of approximately 0.1; 0.2; 0.5; 1.0 times I_n .		P
	If the SPD contains only voltage limiting components then this test need only be carried out at I_n .		P
	b) One sequence of positive polarity and one sequence of negative polarity are applied to the SPD.		P
	c)Finally, at least one impulse of I_{max} or I_{peak} providing I_{max} or I_{peak} is above I_n is applied to the SPD at the polarity that showed higher residual voltages in previous tests.		P
	d)The interval between individual impulses shall be long enough for the sample to cool down to ambient temperature.		P
	e)A current and a voltage oscillogram shall be recorded for each impulse. The (absolute) peak values shall be plotted into a discharge current versus residual voltage diagram. A curve which best fits the data points shall be drawn. There shall be sufficient points on the curve to ensure that there are no significant deviations on the curve up to I_{max} or I_{peak} .		P
	f)The residual voltage used for determining the measured limiting voltage is given by definition as the highest voltage on this curve corresponding in the range of currents for:		P
	-class I: up to I_{peak} or I_n whichever is greater;		N/A
	-class II: up to I_n .		P
7.5.3	Test procedure to measure the front-of-wave sparkover voltage		N/A

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Cl.	Requirement – Test	Result	Verdict
	The 1.2/50 voltage impulse is used. The generator voltage is set to an open circuit output voltage of 6 kV.		N/A
	a)10 impulses are applied to the SPD, five of positive and five of negative polarity.		N/A
	b)The interval between individual impulses shall be long enough to allow the sample to cool down to ambient temperature.		N/A
	c)If sparkover is not observed during any of the 10 impulses on the front of the wave, then a) and b) above are repeated with a generator open circuit output voltage of 10 kV.		N/A
	d)The voltage at the SPD shall be recorded with an oscilloscope.		N/A
	e)The measured limiting voltage is the maximum value of the sparkover voltages recorded during the whole test sequence.		N/A
7.5.4	Test procedure to measure the limiting voltage with the combination wave		N/A
	To perform this test a combination wave is used.		N/A
	a)The combination wave will be applied to an energized SPD, with the mains voltage at U_c .		N/A
	b)For SPDs rated only on a.c. power systems, positive impulses are applied at the $90^\circ \pm 10^\circ$ point and negative impulses at $270^\circ \pm 10^\circ$ point on the sinusoidal voltage waveform.		N/A
	c)For SPDs rated for use on d.c. systems, both positive and negative impulse surges are applied. The SPD will be energized at the d.c. U_c .		N/A
	d)The interval between the individual impulses shall be long enough for the sample to cool down to ambient temperature.		N/A
	e)The voltage of the combination wave generator is set to provide an open-circuit voltage of 0,1; 0,2; 0,5; 1,0 times the U_{oc} as declared by the manufacturer for the SPD.		N/A
	f)With these generator settings four surges will be applied to the SPD at each amplitude: two of positive and two of negative polarity.		N/A
	g)An oscillographic record shall be made of the current delivered by the generator into the SPD and the voltage at the output port of the SPD for each impulse.		N/A

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Cl.	Requirement – Test	Result	Verdict
	h)The measured limiting voltage is the maximum magnitude of the peak voltage recorded during the whole test sequence.		N/A
7.5.5	Alternate test to the combination wave test (7.5.4), without a decoupling network		N/A
	Two-port SPDs with reactive components create interaction with the reactive components of a back filter. This can produce artificially low values of measured limiting voltage. Tests in such cases shall use the alternative test method in figure 4.		N/A
	For two-port SPDs with reactive components the following test procedure shall be adopted in addition to that of 7.5.4.		N/A
	a)The test generator shall be configured as in figure 4.		N/A
	b)For a.c. rated SPDs a d.c. voltage of $U_c \sqrt{2}$, for d.c. rated SPDs a d.c. voltage of U_c , shall be applied to the SPD via a diode. The impulse shall be applied via a diode, gas discharge tube, or varistor according to figure 4.		N/A
	c)The application of the impulse should occur at least 100 ms after closure of S1. The d.c. voltage should be disconnected within 10 ms after impulse application.		N/A
	d)Reverse polarity tests can be conducted by reversing the SPD connection to the generator.		N/A
	e)The interval between individual impulses shall be long enough for the sample to cool down to ambient temperature.		N/A
	f)The voltage of the combination wave generator is set to provide an open-circuit voltage of 0,1; 0,2, 0,5; 1,0 times the U_{oc} as declared by the manufacturer.		N/A
	g)With these generator settings, four surges will be applied to the SPD at each amplitude: two of positive polarity and two of reverse polarity.		N/A
	h)An oscillographic record shall be made of the current delivered by the generator into the SPD and the voltage at the output port for each impulse.		N/A
	i)The measured limiting voltage is the maximum magnitude of the voltage recorded at the output of the SPD for the whole test sequence.		N/A
7.6	Operating duty test		P
	These tests are applicable only for SPDs used on a.c. (SPDs used on d.c. are under consideration).		P

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Cl.	Requirement – Test	Result	Verdict
7.6.1	General		P
	This is a test in which service conditions are simulated by the application of a stipulated number of specified impulses to the SPD while it is energized at the maximum continuous operating voltage U_c via an a.c. source according to 7.6.3.		P
	The test shall be made on three new samples which have not been subjected previously to any tests.		P
	First the measured limiting voltage shall be determined using the tests described in 7.5.		P
	To avoid overstress of the samples, the test of 7.5.2 is performed only at I_n and the tests of 7.5.4 and 7.5.5 only at U_{oc} .		N/A
7.6.2	Preliminary test to determine the magnitude of the follow current		P
	This preliminary test is intended to determine if the peak value of the follow current is above or below 500 A.		P
	If the internal design and the peak value of the follow current of the SPD are known, this preliminary test is not required.		P
	a) The test shall be made with a separate test sample.		P
	b) The prospective short circuit current shall be $I_p \geq 1.5$ kA with a power factor $\cos \phi = 0.95$.		P
	c) It is connected to a power frequency voltage source with sinusoidal a.c. voltage. The power frequency voltage measured at the terminals, shall be the maximum equal to the continuous maximum operating voltage U_c $\pm 5\%$. The frequency of the a.c. voltage source shall correspond to the rated frequency of the SPD.		P
	d) The follow current shall be initiated with an impulse current 8/20 or a combination wave.		P
	e) The peak value shall correspond to I_{max} or I_{peak} or U_{oc} .		P
	f) The current impulse shall be initiated 60 electrical degrees before the peak of the power frequency voltage. Its polarity shall coincide with the polarity of the half wave of the power frequency voltage in which it is initiated.		P
	g) If at this synchronization point there is no follow current, then the impulse current 8/20 has to be initiated later in steps of 10 electrical degrees each in order to determine if a follow current is generated.		P

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Cl.	Requirement – Test	Result	Verdict
7.6.3	Power frequency source characteristics for preconditioning		P
7.6.3.1	SPDs with follow current below 500 A		P
	The test sample shall be connected to a power frequency voltage source. The impedance of the power source shall be such that during the flow of follow current the peak value of the power frequency voltage, measured at the SPD terminals, does not fall below the peak value of its U_c by more than 10 %.		P
7.6.3.2	SPDs with follow current above 500 A		N/A
	The test sample shall be connected to a power frequency voltage U_c with a prospective short-circuit current equal to the follow current interrupt rating I_{fi} declared by the manufacturer in accordance with Table 11, or 500 A, whichever is greater.		N/A
	For SPDs connected between neutral and protective earth only, the prospective short-circuit current shall be at least 100 A.		N/A
7.6.4	Class I and II preconditioning tests		P
	For this test, 15 current impulses 8/20 of positive polarity in three groups of five impulses each with peak values equal to I_{peak} or I_n , whichever is greater, for test class I and equal to I_n for test class II are applied through the test sample connected to a power source according to 7.6.3. Each impulse shall be synchronized to the power frequency. Starting from 0° the synchronization angle shall be increased in steps of $(30 \pm 5)^\circ$ intervals. The tests are described in Figure 6.		P
	When testing SPDs to class I, current impulses with values equal to I_{peak} or I_n , whichever is greater, are applied.		N/A
	When testing SPDs to class II, current impulses with values equal to I_n , are applied.	10 kA	P
	The interval between the impulses is 50 s-60 s, the interval between the groups 25 min-30 min.		P
	It is not required that the test sample be energized between groups.		P
	The current shall be recorded at each impulse and the current records shall show no sign of puncture or flashover of the samples.		P
7.6.5	Class I and II operating duty test		P

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Cl.	Requirement – Test	Result	Verdict
	The SPD is energized at U_c by means of a voltage source having a nominal current capability of at least 5 A. This test is carried out with current impulses in steps up to I_{peak} (according to 3.9) or I_{max} (according to 3.10) through the SPD.		P
	The power frequency voltage remains applied for 30 min after each impulse to prove the thermal stability: the SPD is considered to be thermally stable if the peak of the resistive component of I_c , or the power dissipation steadily decreases during the last 15 min of U_c voltage application.		P
	Current impulses of positive polarity shall be initiated in the corresponding positive peak value of the power frequency voltage source to the energized test sample as follows.		P
	a) One current impulse at 0.1 (I_{peak} or I_{max}); check thermal stability; cool down to ambient temperature.		P
	b) One current impulse at 0.25 (I_{peak} or I_{max}); check thermal stability; cool down to ambient temperature.		P
	c) One current impulse at 0.5 (I_{peak} or I_{max}); check thermal stability; cool down to ambient temperature.		P
	d) One current impulse at 0.75 (I_{peak} or I_{max}); check thermal stability; cool down to ambient temperature.		P
	e) One current impulse at 1.0 (I_{peak} or I_{max}); check thermal stability; cool down to ambient temperature.		P
7.6.6	Pass criteria		P
	The SPD has passed the test if thermal stability is achieved after each impulse of the preconditioning and operating duty cycle. Additionally, any follow current has to be selfextinguished. Both the voltage and current records and visual inspection shall show no indication of puncture or flashover of the samples. Mechanical damage shall not occur during these tests.		P
	One more impulse at I_n or U_{OC} shall be applied to the SPD whilst the SPD is energized at U_c by means of a voltage source having a nominal current capability of at least 5 A. After this impulse, U_c remains applied and thermal stability shall be achieved within 30 min.		P
	Once thermal stability is achieved, either:		P

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Cl.	Requirement – Test	Result	Verdict
	the current which flows through the test sample is measured. Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA.		P
	or in case of this current exceeds 1 mA		P
	the stand-by power consumption shall not be greater than 20% above the value measured in 7.7.5		P
	Following this complete test sequence and after the sample has cooled down to near ambient temperature, the measured limiting voltage test, which was made at the beginning of the test sequence, shall be repeated. The SPD has passed the test, if the values measured before and after the test are below or equal to U_p .		P
7.6.7	Class III operating duty test	Not class III	N/A
	For the operating duty test of class III SPDs, a power frequency voltage source according to 7.6.3 is used.		N/A
	The combination wave generator is connected to the SPD via a coupling capacitor (see 7.1.4). The tolerance on waveform parameters as shown in table 4 shall be met at the point where the SPD will be connected. The value of U_{oc} is declared by the manufacturer.		N/A
	The SPD is preconditioned according to the test procedure of 7.6.4. For the purpose of this test, the nominal discharge current is replaced by values of U_{oc} .		N/A
	The current impulse shall be initiated at the peak value of the corresponding half cycle and in the same polarity of the power frequency voltage.		N/A
	The operating duty test is performed according to 7.6.5 using the combination wave generator with the following generator settings U_{oc} .		N/A
	a) One positive and one negative impulse at 0.1 U_{oc} ; check thermal stability; cool down to ambient temperature.		N/A
	b) One positive and one negative impulse at 0.25 U_{oc} ; check thermal stability; cool down to ambient temperature.		N/A
	c) One positive and one negative impulse at 0.50 U_{oc} ; check thermal stability; cool down to ambient temperature.		N/A

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Cl.	Requirement – Test	Result	Verdict
	d)One positive and one negative impulse at 0.75 Uoc; check thermal stability; cool down to ambient temperature.		N/A
	e)One positive and one negative impulse at 1.0 Uoc; check thermal stability; cool down to ambient temperature.		N/A
	The SPD has passed the test if the criteria of 7.6.6 are fulfilled.		N/A
7.7	SPD disconnectors and safety performance of overstressed SPDs		P
	General		P
	These tests shall be made on every SPD. Tests are performed on each mode of protection of the SPD using new samples each time.		P
7.7.1	Operating duty withstand test of SPD disconnectors		P
	The SPD disconnector(s) is(are) tested during the operating duty test (see 7.6). The disconnectors, as specified by the manufacturer, shall not operate during the test and shall be in working order after this test.		P
	For the purpose of this clause, working order means that the disconnector is not visibly damaged and is still operational. Operation can be checked either manually (where possible) or by a simple electrical test agreed between the manufacturer and the laboratory.		P
7.7.2	Test of thermal stability of SPDs		P
7.7.2.1	Temperature withstand test		P
	The SPD is kept in a heated cabinet at an ambient temperature of 80 °C ± 5 K for 24 h. No internal SPD disconnector shall operate during this time.		P
7.7.2.2	Thermal stability test		P
	This test is not performed on SPDs containing only voltage switching components.		P
	Test settings		P
	This test shall be performed on each mode of protection; however, if some modes of protection have identical circuitry, one single test can be performed on the mode of protection which presents the most vulnerable configuration. This test procedure addresses two different designs:		P

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Cl.	Requirement – Test	Result	Verdict
	-SPDs containing only voltage limiting components. In this case, the following procedure a) applies;		P
	-SPDs containing both voltage limiting and voltage switching components. In this case, the following procedure b) applies.		P
	Any voltage switching component which is connected in series with a voltage limiting component shall be short-circuited by a copper wire with a diameter such that it does not melt during the test.		P
	a)Test procedure for SPDs having no switching component in series with other components		P
	The voltage shall be high enough to allow a current to flow through the SPD. For this test, the current is set to a constant value. The tolerance for the test current is $\pm 10\%$. The test is started at a value of 2 mA r.m.s.		P
	The starting point may be changed from 2 mA to a current corresponding to the maximum power dissipation of the component, if it is known.		P
	This value of current is then increased in steps of either 2 mA or 5% of the previously adjusted test current, whichever is greater.		P
	Each step is maintained until thermal equilibrium is reached (i.e. variation of temperature less than 2 K within 10 min).		P
	The surface temperature on the hottest spot of the SPD (for accessible SPDs only) and the current through the SPD are monitored continuously. The hottest spot of the SPD may be determined by an initial test or alternatively many points may be monitored in order to determine the hottest spot.		P
	This test is interrupted if all non-linear components under test are disconnected. The voltage shall not be increased further in order to avoid any malfunction of the disconnecter.		P
	If the voltage across the SPD falls below U_{cs} during the test, the current regulation is discontinued and the voltage is adjusted back to U_{cs} and maintained for a duration of 15 min.		P
	b)Test procedure for SPDs having a switching component in series with other components		N/A

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Cl.	Requirement – Test	Result	Verdict
	The SPD is energized with a power frequency source at U_{Cs} and having a short-circuit current capability which will not limit the current before any disconnector operates. The maximum available current value shall not exceed the short-circuit withstand capability declared by the manufacturer.		N/A
	If no significant current flows, test procedure a) shall be followed.		N/A
	Pass criteria		P
	If a disconnector operates, there shall be clear evidence of effective and permanent disconnection by the device. To check this, a power frequency voltage equal to U_c shall be applied for 1 min without current flow in excess of 0.5 mA r.m.s.		P
	Indoor SPDs: The surface temperature rise shall be less than 120 K during the test. The surface temperature shall not exceed 80 K above ambient temperature 5 min after the disconnector has operated. During the test there shall be no expulsion of solid material.		P
	Outdoor SPDs: There shall be no evidence of burning and there shall be no expulsion of solid material.	Not outdoor SPD	N/A
	Accessible SPDs: After the test, SPDs having an IP degree equal or greater than IP20 shall not have live parts accessible with the standardized test finger applied with a force of 5 N (see EN 60529), except the live parts which were already accessible before the test when the SPD is fitted as in normal use.		P
7.7.3	Short-circuit withstand capability test in conjunction with overcurrent protection if any		P
	Test settings		P
	Power frequency source characteristic: the prospective short-circuit current and power factor at the SPD terminals, are given by the manufacturer according to table 11. The test voltage is set to U_c .		P
	The test sample shall be mounted in accordance with the manufacturer's published directions.		P

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Cl.	Requirement – Test	Result	Verdict
	The SPD itself, its disconnectors and overcurrent protection shall be placed in a cuboid wooden box whose sides are 500 mm \pm 50 mm away from the SPD external surfaces. The internal surface of the box is covered with tissue paper or cheese cloth. One of the box side (not the bottom one) remains open in order that the supply cables can be connected according to the manufacturer's instructions.		P
	Sample preparation		P
	For SPDs containing only a single non-linear component and for SPDs containing more than one non-linear component only connected in series, every voltage limiting component and voltage switching component of the SPD described in 3.4 and/or 3.5 shall be replaced by appropriate metal (copper) blocks (dummies), ensuring that internal connections, their crosssection and the surrounding material (e.g. resins) and packaging are not changed.		P
	For SPDs with non-linear components connected in parallel, separate sets of three samples shall be prepared in the manner described above, for every current path of the SPD which contains one or more non-linear component as described in 3.4 and 3.5.		P
	Test procedure		P
	The sample is connected to the power frequency source according to Table 11 and the test voltage is set to UC. The test is carried out three times. If a replaceable or a rearmable internal or external disconnector operates, the relevant disconnector shall be replaced or rearmed each time. If the disconnector cannot be replaced or rearmed the test is stopped.		P
	Pass criteria		P
	During the test, the power short-circuit current shall be interrupted within 5 s. During the test, the muslin paper, or cheese cloth shall not catch fire. In addition, there shall be no explosion or other hazard for either personnel or the facility.		P
	Accessible SPDs: after the test, SPDs having an IP rating equal or greater than IP2X shall not have live parts accessible with the standardized test finger applied with a force of 5 N (see IEC 60529), except the ones which are accessible when the SPD is fitted as in normal use.		P

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Cl.	Requirement – Test	Result	Verdict
	There shall be clear evidence of effective and permanent disconnection. To check this, a power frequency voltage equal to UC shall be applied for 1 min. to the disconnector(s) having operated. The current flow shall not exceed 0.5 mA r.m.s.		P
7.7.4	TOV failure test		P
	This test applies to SPDs connected between live terminals and the earth terminal as given in annex B Table B.1.		P
	New samples shall be used and fitted as in normal use, according to the manufacturer's instructions		P
	The SPD is placed in a cuboid wooden box whose sides are 500 mm \pm 50 mm away from the SPD external surfaces. The internal surface of the box is covered with muslin paper or cheese cloth. One of the box sides (not the bottom) remains open in order that the supply cables can be connected according to the manufacturer's instructions.		P
	The live terminals of the SPD (phases and neutral) shall be connected all together and a temporary overvoltage as given in annex B Table B.1 is then applied, for a duration of 200 ms, between the common point and the earth terminal. The voltage source shall have a prospective short circuit current of 300 A. For multi-mode SPDs, where different test voltages are given for different modes of protection, the higher value of voltage is used.		P
	Immediately following the application of this temporary overvoltage, but in any case not longer than 100 ms after this application a voltage equal to UC (+0 %-5 %) shall be applied between the common point and the earth terminal, except for SPDs connected only neutral to ground. The prospective short circuit current of this power source shall be equal to five times the rated current of the maximum overcurrent protection declared by the manufacturer for the SPD or 300 A if no maximum overcurrent protection is declared by the manufacturer. This source shall be applied to the test sample for a period of 1 min. An example of a suitable test circuit is given in Figure 7a.		P
	During the test, the muslin paper or equivalent shall not catch fire.		P
7.7.5	Standby power consumption and residual current test		P

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Cl.	Requirement – Test	Result	Verdict
	The SPD is connected to a voltage source at its maximum continuous operating voltage (UC) in accordance with the manufacturer's instructions. The apparent power (Volt-Amperes) consumed by the SPD is measured. The current flowing through the PE terminal is called the residual current.		P
7.7.6	Test under TOVs caused by faults in the low voltage system		P
7.7.6.1	Test procedure		P
	New samples shall be used and fitted as in normal use, according to the manufacturer's instructions.		P
	The SPD shall be mounted in a cube shaped wooden box as described 7.7.3. The internal surface of the box shall be covered with muslin paper or cheese cloth. One of the box sides (not the bottom) shall remain open in order that the supply cables can be connected according to the manufacturer's instructions.		P
	The test sample shall be connected for a duration of $t_T = 5 s^{+5}_{-5} 0\%$ to a power frequency voltage of $U_T 0_{-5} \%$ as given in Table B.1, or greater TOV-voltages which the manufacturer has declared in accordance with 6.6.1 w). This voltage source shall be capable of delivering a current either high enough to ensure that the voltage at the SPD terminals does not fall below $U_T - 5 \%$ during the test, or equal to the declared short-circuit withstand of the SPD, whichever is lower.		P
	Immediately following the application of U_T a voltage equal to $U_{cs} 0 - 5 \%$ with the same current capability shall be applied to the test sample for a period of 15 min. The time interval between the test periods shall be as short as possible and in any case not exceed 100 ms.		P
7.7.6.2	Pass criteria		P
	The following pass criteria shall be fulfilled		P
	-The muslin paper or cheese cloth shall not catch fire during the test.		P
	-SPDs having an IP degree equal or greater than IP20 shall not have live parts accessible with the standardized test finger applied with a force of 5 N, except for those live parts which were already accessible before the test when the SPD is fitted as in normal use.		P

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Cl.	Requirement – Test	Result	Verdict
	-The SPD shall maintain thermal stability during the application of U_{CS} (following the application of U_T). The SPD is considered to be thermally stable if the current flowing through it or its power dissipation do not continue to increase during the total time of application of U_{CS} .		P
	-The test sample is then connected to UC. The test transformer shall have a short-circuit current capability of at least 200 mA.		P
	The current which flows through the test sample is measured. Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA or the stand-by power consumption shall not increase by more than 20 % of the value measured in 7.7.5.		P
	-After the test sample has cooled down to near ambient temperature, the measured limiting voltage shall be determined, using the tests described in 7.5, in order to check if the voltage protection level specified by the manufacturer has been maintained.		P
	-Visual inspection of the test sample shall reveal no evidence of any damage.		P
7.8	Test for two-port SPDs and one-port SPDs with separate input/output terminals		P
7.8.1	Test to determine the percentage voltage regulation		P
	A voltage U_c is supplied at the input port and shall be constant within -5% . The test shall be conducted with rated load current into a resistive load. Input and output voltage shall be measured simultaneously with load connected. Use the following formula to determine the percentage voltage regulation.		P
	This value shall be recorded and comply with the manufacturer's declaration.		P
7.8.2	Rated load current I_L		N/A
	The SPD shall be powered, as in 7.8.1 at ambient temperature using a cable with the minimum cross-sectional area specified in 7.3.1. The load current shall be set to the rated load current specified by the manufacturer. Forced cooling of the SPD is not permitted.		N/A
	The SPD passes the test if the enclosure has reached thermal stability and the temperature of the parts which are accessible in normal use shall be not more than 40 K above the ambient temperature of the room (see 2.1).		N/A

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Cl.	Requirement – Test	Result	Verdict
7.8.3	Load-side short circuit withstand capability test (in conjunction with SPD disconnectors required by the manufacturer, if any).		P
	The test, according to 7.7.3, is repeated without the short-circuiting of any component but by short-circuiting all load terminals with a conductor of the largest cross section specified under 7.3.1 and of length 0.5 m.		P
	Pass criteria		P
	During the test the power short-circuit current shall be interrupted within 5 s. During the test the muslin paper, or cheesecloth, shall not catch fire. In addition, there shall be no explosion or hazard for either personnel or facility.		P
	Accessible SPDs		P
	After the test, SPDs having an IP degree equal or greater than IP 2X shall not have live parts accessible with the standardized test finger applied with a force of 5 N (see IEC 60529). If no internal disconnector has operated, the SPD shall fulfil the requirements according to 7.4.1 and 7.5. If an SPD internal disconnector has operated, there shall be clear evidence of effective and permanent disconnection.		P
	In checking for disconnection:		P
	a)confirm that there is no voltage on the output terminals		P
	b)apply a power frequency voltage equal to two times UC, between the corresponding input and output terminals for 1 minute without current flow in excess of 0.5 mA r.m.s.		P
	The test shall include all the auxiliary parts in series with the SPD as declared by the manufacturer.		P
7.8.4	Load-side surge withstand capability		P
	For this test		P
	-15 current impulses 8/20		P
	-or 15 combination wave impulses with an open circuit voltage Uoc		N/A

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Cl.	Requirement – Test	Result	Verdict
	with a value equal to the load-side surge withstand capability declared by the manufacturer are applied in three groups of five impulses to the output port of the test sample. The SPD is energized at U_c by means of a voltage source having a nominal current of at least 5 A. Each impulse shall be synchronized to the power frequency. Starting from 0° the synchronization angle shall be increased in steps of $30^\circ \pm 5^\circ$.		P
	The interval between the impulses is 50 s - 60 s and the interval between the groups is 25 min- 30 min.		P
	The test sample shall be energized during the whole test sequence. The voltage on the output terminals shall be recorded.		P
	Pass criteria		P
	The SPD has passed the test if the criteria according to 7.6.6 are fulfilled.		P
7.8.5	Overload behaviour		P
	The test is carried out at ambient temperature and the sample shall be protected against abnormal external heating or cooling.		P
	The test circuit and procedure shall be as described in 7.8.2, except that circuits other than the main circuit are disregarded for this test.		P
	The test is performed without any external overcurrent protective devices being connected (internal removable overcurrent protective devices are replaced by a link of negligible impedance).		P
	If a maximum overcurrent protection is specified by the manufacturer, the SPD shall be loaded for 1 h with a current equal to 1.6 times that maximum overcurrent protection.		P
	If no maximum overcurrent protection is specified by the manufacturer, the SPD shall be loaded with 1.1 times the rated load current for 1 h or until an internal disconnecter operates. If no disconnecter operates within 1 h, the test is continued by increasing the previous value of test current by a factor of 1.1 every hour, until an internal disconnecter operates.		P
	Pass criteria		P
	For touchable surfaces, the temperature rise shall always be less than 60 K during the test.		P
7.9	Additional tests		P

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Cl.	Requirement – Test	Result	Verdict
	The entire subclause 7.9 is a safety issue. In some countries other national regulations may apply.		P
7.9.1	Portable SPDs with flexible cables and cords and their connection	Not portable SPDs	N/A
7.9.1.1	Portable SPDs shall be provided with a cord anchorage such that the conductors are relieved from strain, including twisting, where they are connected to the terminals or terminations, and that their covering is protected from abrasion.		N/A
	The sheath, if any, of the cord shall be clamped within the cord anchorage.		N/A
	Compliance is checked by inspection.		N/A
7.9.1.2	The effectiveness of the retention is checked by the following test by means of an apparatus as shown in Figure 8		N/A
	Non-rewireable SPDs are tested as delivered; the test is made on new samples.		N/A
	Rewireable SPDs are tested with the cable having the nominal cross-sectional area as declared by the manufacturer.		N/A
	Conductors of the flexible cable or cord of rewireable accessories are introduced into the terminals, screws being tightened just sufficiently to prevent the position of the conductors from easily changing.		N/A
	After reassembly of the sample, the component parts shall fit snugly and it shall not be possible to push the cable or cord into the sample to any appreciable extent.		N/A
	The sample is placed in the test apparatus so that the axis of the cable or cord is vertical where it enters the sample.		N/A
	The cable or cord is then subjected 100 times to a pull of		N/A
	-60 N if the rated current is not more than 16 A and the rated voltage is up to and including 250 V;		N/A
	-80 N if the rated current is not more than 16 A and the rated voltage is above 250 V;		N/A
	-100 N if the rated current is more than 16 A.		N/A
	The pulls are applied practically without jerks each time for 1 s.		N/A
	Care shall be taken to exert the same pull on all parts (core, insulation and sheath) of the flexible cable simultaneously.		N/A

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Cl.	Requirement – Test	Result	Verdict
	After the tests, the cable or cord shall not have been displaced by more than 2 mm. For rewirable accessories, the end of the conductors shall not have moved noticeably in the terminals; for non-rewirable accessories, there shall be no break in the electrical connections.		N/A
	For measurement of the longitudinal displacement, a mark is made on the cable or cord while it is subjected to the pull, at a distance of approximately 20 mm from the end of the sample or the cord guard, before starting the tests. If, for non-rewirable accessories, there is no definite end to the sample or the cord guard, an additional mark is made on the body of the sample.		N/A
	After these tests, the displacement of the mark on the cable or cord in relation to the sample or the cord guard is measured while the cable or cord is subjected to the pull.		N/A
7.9.1.3	Non-rewirable SPDs shall be provided with a flexible cable or cord complying with IEC 60227 and IEC 60245 with a cross-sectional area of the conductors suitable for the maximum rating of the SPD and associated equipment.		N/A
	Compliance is checked by inspection, by measurement, and by checking that the flexible cables or cords are in accordance with IEC 60227 or IEC 60245, as applicable.		N/A
7.9.1.4	Non-rewirable SPDs shall be so designed that the flexible cable or cord is protected against excessive bending where it enters the accessory.		N/A
	Guards provided for this purpose shall be of insulating material and shall be fixed in a reliable manner.		N/A
	Helical metal springs, whether bare or covered with insulating material, shall not be used as core guards.		N/A
	Compliance is checked by inspection and by a flexing test made by means of an apparatus as shown in figure 9.		N/A
	The test is made on new samples.		N/A
	The sample is fixed to the oscillating mechanism of the apparatus. Therefore when it is in midposition, the axis of the flexible cable or cord where it enters the sample is vertical; thus passing through the axis of oscillation.		N/A

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Cl.	Requirement – Test	Result	Verdict
	The accessory is, by variation of the distance between the fixed part of the oscillating mechanism and the axis of oscillation, so positioned that the cord makes the minimum lateral movement when the oscillating mechanism of the test apparatus is moved over its full length of travel.		N/A
	In order to have the possibility of finding easily by experiment the mounting position with the minimum lateral movement of the cord during the test, the flexing apparatus should be built in such a way that the different supports for the accessories mounted on the oscillating mechanism can be readily adjusted.		N/A
	The cable or cord is loaded with a mass such that the force applied is		N/A
	-20 N for accessories with cables or cords having a nominal cross-sectional area exceeding 0.75 mm^2 ;		N/A
	-20 N for accessories with cables or cords having a nominal cross-sectional area exceeding 0.75 mm^2 ;		N/A
	-2,5 A for accessories with cords having a nominal cross-sectional area less the $0,75 \text{ mm}^2$.		N/A
	The voltage between the conductors is equal to the rated voltage of the sample.		N/A
	The oscillating mechanism is moved through an angle of 90° (45° on either side of the vertical), the number of flexings being 10 000 and the rate of flexing 60 per minute.		N/A
	A flexing is one movement, either backwards or forwards.		N/A
	Samples with circular section cables or cords are turned through 90° in the oscillating mechanism after 5 000 flexings, samples with flat cords are only bent in a direction perpendicular to the plane containing the axes of the conductors.		N/A
	During the flexing test, there shall be		N/A
	-no interruption of the current,		N/A
	-no short-circuit between conductors.		N/A

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Cl.	Requirement – Test	Result	Verdict
	A short-circuit between the conductors of the flexible cable or cord is considered to occur if the current attains a value equal to twice the test current of the accessory.		N/A
	The voltage drop between each contact and the corresponding conductor, with a test current flowing having a value of the rated current, shall not exceed 10 mV.		N/A
	After the test the guard, if any, shall not have separated from the body and the insulation of the flexible cable or cord shall show no sign of abrasion or wear; broken strands of the conductor shall not have pierced the insulation so as to become accessible.		N/A
7.9.2	Mechanical strength		P
7.9.2.1	SPDs shall have adequate mechanical strength so as to withstand the stresses imposed during installation and use.		P
	Compliance is checked by the appropriate tests as follows:		P
	The samples are subjected to strikes by means of an impact-test apparatus as shown in figure 10.		P
	The striking element has a hemispherical face, 10 mm radius, made of polyamide having a Rockwell hardness of HR 100, and has a mass of 150 g \pm 1 g.		P
	It is rigidly fixed to the lower end of a steel tube with an external diameter of 9 mm and a wall thickness of 0,5 mm, which is pivoted at its upper end in such a way that it swings only in a vertical plane.		P
	The axis of the pivot is 1 000 mm \pm 1 mm above the axis of this striking element.		P
	The Rockwell hardness of the polyamide striking element is determined by using a ball having a diameter of 12.700 mm \pm 0.0025 mm, the initial load 100 N \pm 2 N and the extra load 500 N \pm 2.5 N.		P
	The design of the apparatus is such that a force of between 1.9 N and 2.0 N has to be applied to the face of the striking element to maintain the tube in a horizontal position.		P
	The samples are mounted on a sheet of plywood, 8 mm thick and 175 mm square, secured at its top and bottom edges to a ridged bracket.		P
	Portable SPDs are tested as fixed SPDs, but they are fixed to the plywood sheet by auxiliary means.		N/A

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Cl.	Requirement – Test	Result	Verdict
	The mounting support shall have a mass of 10 kg \pm 1 kg and shall be mounted on a rigid frame.		P
	The design of the mounting is such that		P
	-the sample can be so placed that the point of impact lies in the vertical plane through the axis of the pivot,		P
	-the sample can be displaced horizontally and turned about an axis perpendicular to the surface of the plywood,		P
	-the plywood can be turned around a vertical axis.		P
	Flush-type SPDs are mounted in a recess provided in a block of hornbeam or material having similar mechanical characteristics, which is fixed to a sheet of plywood. (They are not tested in their relevant mounting boxes.)		N/A
	If wood is used for the block, the direction of the wood fibres shall be perpendicular to the direction of the impact.		N/A
	Flush-type screw fixing SPDs shall be fixed by means of screws to lugs recessed in the block. Flush-type claw fixing SPDs shall be fixed to the block by means of the claws.		N/A
	Before applying the strikes, fixing screws of bases and covers are tightened with a torque equal to two-thirds of that specified in table 12.		N/A
	The samples are mounted so that the point of impact lies in the vertical plane through the axis of the pivot.		P
	The heights of the fall determined by the part of the sample which projects most from the mounting surface is applied on all parts of the sample, with the exception of parts A.		P
	The height of fall is the vertical distance between the position of a checking point when the pendulum is released, and the position of that point at the moment of impact. The checking point is marked on the surface of the striking element where the line through the point of intersection of the axes of the steel tube of the pendulum and the striking element and perpendicular to the plane through both axes, meets the surface.		P
	The samples are subjected to strikes which are evenly distributed over the samples. The strikes are not applied to "knock-out" areas.		P

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Cl.	Requirement – Test	Result	Verdict
	The following blows are applied:		P
	-for parts A, five strikes: one in the centre. After the sample has been moved horizontally: one each on the unfavourable points between the centre and the edges; and then, after the sample has been turned 90° about its axis perpendicular to the plywood, one each on similar points;		P
	-for parts B (as far as applicable), C and D, four blows:		P
	-one on one side of the sample after the plywood sheet has been turned 60° and one blow on another side of the sample after it has been turned 90° about its axis perpendicular to the plywood sheet, keeping the position of the plywood sheet unchanged;		P
	-one blow on each of the other two sides of the sample, with the plywood sheet turned 60° in the opposite direction.		P
	After the test, the sample shall show no damage within the meaning of the standard. In particular, live parts shall not become accessible with the standard test finger.		P
	Damage to the finish, small dents which do not reduce creepage distances or clearances and small chips which do not adversely affect the protection against electric shock or harmful ingress of water are neglected.		P
	Cracks, not visible with the normal or corrected vision, without additional magnification, and surface cracks in fibre reinforced mouldings and the like, are ignored.		P
7.9.2.2	Portable SPDs are tested in a tumbling barrel as shown in figure 11.		N/A
	Rewireable SPDs are fitted with the flexible cable or cord specified by the manufacturer and a free length of approximately 100 mm.		N/A
	Terminal screws and assembly screws are tightened with a torque equal to two-thirds of that specified in table 12.		N/A
	Non-rewireable SPDs are tested as delivered, the flexible cable or cord being cut so that a free length of about 100 mm projects from the accessory.		N/A

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Cl.	Requirement – Test	Result	Verdict
	The samples fall from a height of 500 mm onto a steel plate, 3 mm thick, the number of falls being the following:		N/A
	-1 000 if the mass of the sample without cable or cord does not exceed 100 g;		N/A
	-500 if the mass of the sample without cable or cord exceeds 100 g, but does not exceed 200 g;		N/A
	-100 if the mass of the sample without cable or cord exceeds 200 g.		N/A
	The barrel is turned at a rate of five revolutions per minute, ten falls per minute thus taking place. Only one sample is tested in the barrel at a time.		N/A
	After the test, the samples shall show no damage. In particular		N/A
	-no part shall have become detached or loosened,		N/A
	-it should not be possible to touch any live parts, even if the standard test finger is applied with a force not exceeding 10 N.		N/A
	During the examination after the test, special attention is paid to the connection of the flexible cable or cord. Small pieces may be broken off without rejection, provided that the protection against electric shock is not affected.		N/A
	Damage to the finish and small dents which do not reduce the creepage distances or clearances are neglected.		N/A
	The measured limiting voltage shall be determined using the tests described in 7.5.		N/A
	The test of 7.5.2 is performed only at I_n and the tests of 7.5.4 and 7.5.5 only at U_{oc} . For the test of 7.5.3, the maximum of 10 measured peak values shall be used.		N/A
	The sample has passed the test if the measured limiting voltage is below or equal to U_P .		N/A
	The test sample is then connected to a voltage source with a maximum continuous operating voltage U_c and the rated frequency. The test transformer shall have a short circuit current capability of at least 200 mA unless other values are provided by the manufacturer.		N/A
	Whilst this power source is applied either		N/A

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Cl.	Requirement – Test	Result	Verdict
	the resistive component of the current which flows through the test sample (measured at the crest of the sine wave) shall not exceed a value of 1 mA.		N/A
	or in case of this current exceeds 1 mA,		N/A
	the stand-by power consumption shall not be greater than 20 % above the value measured in 7.7.5.		N/A
7.9.3	Heat resistance		P
7.9.3.1	For 1 h the SPD is kept in a heating cabinet at a temperature of $100^{\circ}\text{C} \pm 2 \text{ K}$. Any sealing compound used in the internal assembly shall not flow out to any significant extent.		P
	After cooling, it should not be possible to touch any live parts when the test sample is mounted as for normal use even if the standard test finger is applied with a force not exceeding 5 N.		P
	The SPD is deemed to have passed the test even if the SPD disconnecter is open.		P
7.9.3.2	Outer parts of SPDs, consisting of insulating material, are submitted to a ball thrust test by means of a tester as shown in Figure 12.		P
	Parts of insulating material necessary to retain current carrying parts and parts of the earthing circuit in position are tested in a heating cabinet at $125^{\circ}\text{C} \pm 2 \text{ K}$.		P
	Parts of insulating material not necessary to retain current carrying parts and parts of the earthing circuit in position, even though they are in contact with them, are tested at $70^{\circ}\text{C} \pm 2 \text{ K}$.		P
	The sample to be tested is fastened accordingly, its surface being positioned horizontally; a steel ball having a diameter of 5 mm is pressed against the surface with a force of 20 N.		P
	After 1 h, the steel ball is taken away from the sample; by dipping it into cold water, the temperature of the sample is reduced to ambient temperature within 10 s.		P
	The diameter of the ball indentation is measured and shall not exceed 2 mm.		P
7.9.4	Resistance to abnormal heat and fire		P
	The glow wire test is performed in accordance with clauses 4 to 10 of IEC 60695-2-1/1 under the following conditions:		P

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Cl.	Requirement – Test	Result	Verdict
	-for external parts of SPDs made of insulating material necessary to retain in position current-carrying parts and parts of the protective circuit, by the test made at a temperature of 850 °C ± 15 K;	White enclosure: 850 °C	P
	-for all other external parts made of insulating material, by the test made at a temperature of 650 °C ± 10 K.	Red enclosure: 650 °C	P
	For the purpose of this test, bases of surface-type SPDs are considered as external parts.		P
	The test is not made on parts of ceramic material.		P
	If the insulating parts are made of the same material, the test is carried out only on one of these parts, according to the appropriate glow-wire test temperature.		P
	The glow-wire test is applied to ensure that an electrically heated test wire under defined test conditions does not cause ignition of insulating parts, or to ensure that a part of insulating material, which might be ignited by the heated test wire under defined conditions, has a limited time to burn without spreading fire by flame or burning parts or droplets falling down from the tested part.		P
	The test is made on one sample.		P
	In case of doubt, the test is repeated on two further samples.		P
	The test is made by applying the glow-wire once.		P
	The sample shall be positioned during the test in the most unfavourable position of its intended use (with the surface tested in a vertical position).		P
	The tip of the glow-wire shall be applied to the specified surface of the test sample taking into account the conditions of intended use under which a heated or glowing element may come into contact with the sample.		P
	The sample is regarded as having passed the glow-wire test if		P
	-there is no visible flame and no sustained glowing, or if		P

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Cl.	Requirement – Test	Result	Verdict
	-flames and glowing parts on the sample extinguish themselves within 30 s after the removal of the glow-wire.		P
	There shall be no ignition of the tissue paper or scorching of the pinewood board.		P
7.9.5	Verification of air clearances and creepage distances		P
	The electrode spacing of spark gaps shall not be considered for the determination of air clearances and creepage distances.		P
7.9.5.1	SPDs category outdoor		N/A
	Between live parts and earth, the air clearances and creepage distances shall not be smaller than the values indicated in table 14.		N/A
7.9.5.2	SPDs category indoor		P
	Air clearances and creepage distances shall not be smaller than the values indicated in table 15.		P
7.9.5.2.1	Test: Measurement		P
	The measurements are carried out without conductors as well as with conductors of the greatest cross-sectional area indicated by the manufacturer. Nuts and screws with out-of-round heads are assumed to be in the most unfavourable tightening position. If there is a partition, the air clearance is measured across the partition; where the partition consists of two parts which are not joined together, the air clearance is measured through the separating gap. Distances due to slits or holes in outer parts out of isolating material are measured against a metal foil on the touchable surface: for this purpose the foil is not pressed into the holes. By means of the test finger (see 7.9.1) it shall be pushed into corners and similar.		P
	In the case that there is a cavity in the course of the creepage distance, its profile is only considered, if it is at least 1mm wide; cavities smaller than 1mm are only considered in their width.		P

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Cl.	Requirement – Test	Result	Verdict
	In the case that there is a partition made out of two parts which are not glued together, the creepage distance is measured through the separating gap. If the air gap between a live part and a partition with fitting surfaces is smaller than 1 mm, only the distance through the separating surface is considered, which is then looked upon as creepage distance. If not, the whole distance, namely the sum out of air gap and the distance through the separating surface, is taken as air clearance. If metal parts are covered with self-hardening resin of a least 2 mm thickness, or if they are covered with an insulation, withstanding a test voltage according to 7.9.8, creepage distances and air clearances are not necessary.		P
7.9.5.2.2	The casting shall not come over the rim of the deepening, it shall stick strongly to the walls of the cavity and the metal parts in it.		P
	Testing: examination and trial to detach the casting mass without a tool.		P
7.9.6	Tracking resistance		P
	Testing is not applicable in case of insulating materials made out of ceramic, or if the creepage distances are at least equal to double the values indicated in 7.9.5.		P
	Testing according to IEC 60112, solution A with a test voltage of 175 V.		P
7.9.7	Insulation resistance		P
	This test is not applicable to SPDs having a metallic enclosure connected to protective earth.		P
7.9.7.1	The test samples shall be prepared as follows:		P
	Additional entry holes for cables – if there are any – are left open; if there are any knock-outs, one of them is opened. Coverings and other parts, detachable without tools, are removed and – if necessary – undergo the same moisture treatment. The moisture treatment is carried out in a humidity cabinet with a relative humidity between 91% and 95%. The air temperature is kept at all points, where the test sample can be positioned, within ± 1 K at a suitable value T between 20°C and 30°C. Before putting the test samples into the humidity cabinet, they shall have a temperature between T and (T+4) in °C.		P
	The test samples shall be kept in the humidity cabinet for 2 days (48 h).		P

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Cl.	Requirement – Test	Result	Verdict
7.9.7.2	After a delay period of between 30 min and 60 min following the humidity treatment, the insulation resistance is measured 60 s after having applied a d.c. voltage of 500 V.		P
	This measurement is carried out in the humidity cabinet or in the room into which the specimens were brought to reach the determined temperature, after having fixed again the parts which might have been detached.		P
	The measuring has to be done as follows:		P
	a)between all interconnected live parts and the SPDs body accessible to accidental contact The expression "body" in the sense of this test means		P
	-all touchable metal parts and a metal foil on surfaces of insulating material, which are touchable after installation as for normal use,		P
	-the surface on which the SPD is mounted, if necessary, covered with metal foil,		P
	screws and other facilities for fastening the SPD on its support.		P
	For these measurements, the metal foil is put on in such a way, that perhaps existing casting mass is effectively tested.		P
	Protective components connected to PE may be disconnected for this test.		P
	b)between the live parts of the SPD main circuit and live parts of auxiliary circuits, if there are any.		P
	The insulation resistance shall not be lower than		P
	5 MS for the measurements according to a),		P
	2 MS for the measurements according to b).		P
7.9.8	Dielectric withstand		P
	SPDs classified for outdoor use are tested between the terminals with the internal parts removed. During this test, the SPD is subjected to sprinkling according to 9.1 of IEC 60060-1.		P
	SPDs category indoor are tested as indicated in a) and b) of 7.9.7.2.		P
	SPDs are tested with an a.c. voltage according to table 16. Starting with not more than half the required a.c. voltage, this voltage is increased to the full value within 30 s which is then held for 1 min.	AC 2.2 kV test voltage	P

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Cl.	Requirement – Test	Result	Verdict
	Arcing or puncturing shall not occur, however, partial discharges are accepted if the voltage change during the discharge is less than 5 %.		P
	The power transformer used for testing shall be designed in such a way that after having been adjusted to the test voltage at its open terminals it will generate a short-circuit current of at least 200 mA after short-circuiting the terminals. An overcurrent relay, if any, shall only react if the test circuit current exceeds 100 mA. The device for measuring the test voltage shall have a precision of $\pm 3\%$.		P
	Auxiliary circuits are tested according to IEC 60947-5-1.		P
7.9.9	Resistance to ingress of solid objects and to harmful ingress of water		P
	Testing shall be carried out in accordance with IEC 60529 to check the IP code.	IP20	P
7.9.10	Total discharge current test for multipole SPDs		P
	Test settings		P
	One side of the test generator is connected to the PE or PEN terminal of the multipole SPD. Each of the remaining terminals is connected via a typical series impedance consisting of a resistance of 30 m Ω and an inductance of 25 μ H, to the other side of the generator.		P
	Smaller impedances may be used if the tolerances for the proportional surge currents according to Table 17 are met.		P
	Test procedure		P
	The multipole SPD shall be tested once with the total discharge current I_{Total} declared by the manufacturer.		P
	Pass criteria		P
	-Each mode of the test sample is then connected to U_C . The test transformer shall have a shortcircuit current capability of at least 200 mA.		P
	-The current which flows through the test sample is measured. Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA or the stand-by power consumption shall not increase by more than 20 % of the value measured in 7.7.5.		P

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Cl.	Requirement – Test	Result	Verdict
	-After the test sample has cooled down to near ambient temperature, the measured limiting voltage shall be determined using the tests described in 7.5 to check if the voltage protection level specified by the manufacturer has been maintained. The test of 7.5.2. is performed only at In. Auxiliary circuits, like status indicators, shall be in working order.		P
	-Visual inspection of the test sample shall reveal no evidence of any damage.		P
7.10	Electromagnetic compatibility		P
7.10.1	Electromagnetic immunity		P
	SPDs either incorporating no electronic circuits or incorporating electronic circuits in which all components are passive (for example diodes, resistors, capacitors, inductors, varistors and other surge protective components) are not sensitive to normal electromagnetic disturbances and therefore no immunity tests are required.		P
	The requirements for SPDs containing electronic circuits are under consideration		P
7.10.2	Electromagnetic emission		P
	For SPDs not incorporating electronic circuits, or incorporating electronic circuits that do not generate fundamental frequencies greater than 9 kHz in normal operation, electromagnetic disturbances can only be generated during protective operations. The duration of these disturbances is in the order of microseconds to milliseconds.		P
	The frequency, level and the consequences of these emissions are considered as part of the normal electromagnetic environment of low-voltage installations. Therefore, the requirements for electromagnetic emissions are deemed to be satisfied and no verification is necessary.		P
	The requirements for SPDs containing electronic circuits generating fundamental frequencies greater than 9 kHz are under consideration.		P

TABLE	TABLE: list of critical components				P
Object/part No.	Manufacturer/ trademark	Type/model	Technical data	Standard	Mark(s) of conformity
Enclosure	SABIC INNOVATIVE PLASTICS CHINA CO LTD	923(f1)	Rated V-0 or better, 125 degree, minimum 2.0mm in thickness.	UL 94 UL748C	UL
Terminal Blocks	3M COMPANY COMMUNICATION MARKETS DIV (CMD)	----	600V, 130 degree C	UL1977 UL 467	UL